Goal 6: Ensure availability and sustainable management of water and sanitation for all

Target 6.4: By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity

Indicator 6.4.2: Level of water stress: freshwater withdrawal as a proportion of available freshwater resources

Institutional information

Organization(s):

Food and Agriculture Organization of the United Nations (FAO)

Concepts and definitions

Definition:

The level of water stress: freshwater withdrawal as a proportion of available freshwater resources is the ratio between total freshwater withdrawn by all major sectors and total renewable freshwater resources, after taking into account environmental flow requirements. Main sectors, as defined by ISIC standards, include agriculture; forestry and fishing; manufacturing; electricity industry; and services. This indicator is also known as water withdrawal intensity.

Concepts:

This indicator provides an estimate of pressure by all sectors on the country's renewable freshwater resources. A low level of water stress indicates a situation where the combined withdrawal by all sectors is marginal in relation to the resources, and has therefore little potential impact on the sustainability of the resources or on the potential competition between users. A high level of water stress indicates a situation where the combined withdrawal by all sectors represents a substantial share of the total renewable freshwater resources, with potentially larger impacts on the sustainability of the resources and potential situations of conflicts and competition between users.

Total renewable freshwater resources (TRWR) are expressed as the sum of internal and external renewable water resources. The terms "water resources" and "water withdrawal" are understood here as freshwater resources and freshwater withdrawal.

Internal renewable water resources are defined as the long-term average annual flow of rivers and recharge of groundwater for a given country generated from endogenous precipitation.

External renewable water resources refer to the flows of water entering the country, taking into consideration the quantity of flows reserved to upstream and downstream countries through agreements or treaties.

Total freshwater withdrawal (TFWW) is the volume of freshwater extracted from its source (rivers, lakes, aquifers) for agriculture, industries and services.[1] It is estimated at the country level for the

following three main sectors: agriculture, services (including domestic water withdrawal) and industries (including cooling of thermoelectric plants). Freshwater withdrawal includes fossil groundwater. It does not include non-conventional water, i.e. direct use of treated wastewater, direct use of agricultural drainage water and desalinated water.

Environmental flow requirements (EFR) are defined as the quantity and timing of freshwater flows and levels necessary to sustain aquarian ecosystems, which, in turn, support human cultures, economies, sustainable livelihoods, and wellbeing. Water quality and also the resulting ecosystem services are excluded from this formulation which is confined to water volumes. This does not imply that quality and the support to societies which are dependent on environmental flows are not important and should not be taken care of.[2] Methods of computation of EFR are extremely variable and range from global estimates to comprehensive assessments for river reaches. For the purpose of the SDG indicator, water volumes can be expressed in the same units as the TFWW, and then as percentages of the available water resources.

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1 In AQUASTAT, service water withdrawal is reported as Municipal water withdrawal. ↑

2 They are indeed taken into account by other targets and indicators, such as 6.3.2, 6.5.1, and 6.6.1. ↑

Rationale:

The purpose of this indicator is to show the degree to which water resources are being exploited to meet the country's water demand. It measures a country's pressure on its water resources and therefore the challenge on the sustainability of its water use. It tracks progress in regard to “withdrawals and supply of freshwater to address water scarcity”, i.e. the environmental component of target 6.4.

The indicator shows to what extent water resources are already used, and signals the importance of effective supply and demand management policies. It indicates the likelihood of increasing competition and conflict between different water uses and users in a situation of increasing water scarcity. Increased water stress, shown by an increase in the value of the indicator, has potentially negative effects on the sustainability of the natural resources and on economic development. On the other hand, low values of the indicator indicate that water does not represent a particular challenge for economic development and sustainability.

However, extremely low values may indicate the inability of a country to use properly its water resources for the benefit of the population. In such cases, a moderate and controlled increase in the value of the indicator can be a sign of positive development.

Comments and limitations:

Freshwater withdrawal as a percentage of renewable freshwater resources is a good indicator of pressure on limited water resources, one of the most important natural resources. However, it only partially addresses the issues related to sustainable water management.

Supplementary indicators that capture the multiple dimensions of water management would combine data on water demand management, behavioural changes with regard to water use and the availability of appropriate infrastructure, and measure progress in increasing the efficiency and sustainability of water use, in particular in relation to population and economic growth. They would also recognize the different climatic environments that affect water use in countries, in particular in agriculture, which is the main user of water. Sustainability assessment is also linked to the critical thresholds fixed for this indicator. Although there is no universal consensus on such thresholds, a proposal is presented below.

Trends in freshwater withdrawal show relatively slow patterns of change. Usually, three-five years are a minimum frequency to be able to detect significant changes, as it is unlikely that the indicator would show meaningful variations from one year to the other.

Estimation of water withdrawal by sector may represent a limitation to the computation of the indicator. Few countries actually publish water withdrawal data on a regular basis by sector.

There is no universally agreed method for the computation of incoming freshwater flows originating outside of a country's borders. Nor is there any standard method to account for return flows, the part of the water withdrawn from its source and which flows back to the river system after use. In countries where return flow represents a substantial part of water withdrawal, the indicator tends to underestimate available water and therefore overestimate the level of water stress.

Other limitations that affect the interpretation of the water stress indicator include:

- difficulty to obtain accurate, complete and up-to-date data;
- potentially large variation of sub-national data;
- lack of account of seasonal variations in water resources;
- lack of consideration to the distribution among water uses;
- lack of consideration of water quality and its suitability for use; and
- the indicator can be higher than 100 per cent when water withdrawal non-renewable water (fossil groundwater), when annual groundwater withdrawal is higher than annual replenishment (over-abstraction) or when water withdrawal includes part or all of the water set aside for environmental water requirements.

Some of these issues can be solved through disaggregation of the indicator at the level of hydrological units and by distinguishing between different use sectors. However, due to the complexity of water flows, both within a country and between countries, care should be taken not to double-count.

Methodology

Computation method:

Method of computation: The indicator is computed as the total freshwater withdrawn (TFWW) divided by the difference between the total renewable freshwater resources (TRWR) and the environmental flow requirements (EFR), multiplied by 100. All variables are expressed in km^3/year (10^9 m^3/year).

Stress (%) = TFWW / (TRWR - EFR) * 100

Following the experience of the initial five years of application of the indicator, and consistent with the approach taken during the MDG program, the threshold of 25% has been identified as the upper limit for a full and unconditional safety of water stress as assessed by the indicator 6.4.2.

That means on one hand, that values below 25% can be considered safe in any instance (no stress); on the other, that values above 25% should be regarded as potentially and increasingly problematic, and should be qualified and/or reduced.

Above 25% of water stress, four classes have been identified to signal different levels of stress severity:

NO STRESS <25%

LOW 25% - 50%

MEDIUM 50% - 75%

HIGH 75-100%

CRITICAL >100%

Treatment of missing values:

- ***At country level:***

Three types of imputation are made at country level to fill in missing years in the timeseries:

- - Linear imputation: between two available data-points
  - Carry forward: after the last available data-points and up to 10 years
  - Vertical imputation: in case of available total freshwater withdrawal but missing disaggregation by sources, and if existing disaggregation existed for previous years, the respective ratio by sources is applied to the available total.
- ***At regional and global levels:***

Thanks to the imputation methods at country level, data will be available for the whole time series (unless the latest official value was obtained more than 10 years ago).

Regional aggregates:

Regional and global estimates will be done by summing up the national figures on renewable freshwater resources and total freshwater withdrawal, considering only the internal renewable water resources of each country in order to avoid double counting, and the external renewable freshwater resources of the region as a whole if any. In case of regional aggregation without physical continuity (such as income groupings or Least Developed Countries group, etc.), total renewable water resources are summed up. The EFR at regional level is estimated as the average of the countries' EFRs, in percentage, and applied to the regional water resources.

Sources of discrepancies:

Differences might occur due to the following, amongst others: For national estimates incoming freshwater is counted as being part of the country's available freshwater resources, while global estimates can only be done by adding up the internal renewable water resources (water generated within the country) of all countries in order to avoid double counting. Moreover, external freshwater resources are computed according to treaties, if present, which may lead to different values with respect to the actual freshwater resources assessed through hydrology.

Methods and guidance available to countries for the compilation of the data at the national level:

This indicator provides an estimate of pressure by all sectors on the country's renewable freshwater resources. A low level of water stress indicates a situation where the combined withdrawal by all sectors is marginal in relation to the resources, and has therefore little potential impact on the sustainability of the resources or on the potential competition between users. A high level of water stress indicates a situation where the combined withdrawal by all sectors represents a substantial share of the total renewable freshwater resources, with potentially larger impacts on the sustainability of the resources and potential situations of conflicts and competition between users.

The indicator is computed based on three components:

Total renewable freshwater resources (TRWR)

Total freshwater withdrawal (TFWW)

Environmental flow requirements (EFR)

*Water Stress (%) = TFWW/(TRWR – EFR) *100*

Several documents exist that can be used to support countries in the computation of this indicator. Among them:

Understanding AQUASTAT - FAO's global water information system
This information note covers a twenty year history of the collection and analysis of water-related data and its dissemination as an international public good, freely available to all. The process of collecting and checking the data has resulted in the establishment of a unique network of collaborators who provide data, use data from other countries for comparative purposes, and exchange views and experiences on how best to measure and account for water-related use. Users range from international private companies to non-governmental organizations, and virtually all significant reports related to water depend on the data provided by AQUASTAT.
http://www.fao.org/3/a-bc817e.pdf

Incorporating environmental flows into "water stress" indicator 6.4.2 - Guidelines for a minimum standard method for global reporting.

These guidelines are intended to assist countries to participate in the assessment of SDG 6.4.2 on water stress by contributing data and information on environmental flows (EF). They provide a minimum standard method, principally based on the Global Environmental Flows Information System (GEFIS), which is accessible via http://eflows.iwmi.org.

https://www.unwater.org/app/uploads/2019/01/SDG6_EF_LOW2.pdf

Renewable Water Resources Assessment - 2015 AQUASTAT methodology review
http://www.fao.org/3/a-bc818e.pdf

Global database on municipal wastewater production, collection, treatment, discharge and direct use in agriculture
This paper describes the rationale and method to setup and feed the AQUASTAT database on municipal wastewater production, collection, treatment, discharge or direct use in agriculture. The best available sources of information have been reviewed, including peer-reviewed papers, proceedings of workshops, conferences and expert meetings, global or regional databases, as well as country briefs, national reports and direct communications by country government officials and experts
http://www.fao.org/3/a-bc823e.pdf

Cooling water for energy generation and its impact on national-level water statistics
This technical note, describing the issue of cooling water for energy generation and its impact on national-level water statistics, has two purposes: 1) to act as a general informational resource and 2) to encourage governmental agencies responsible for water usage to gather and report information disaggregated by sub-sector (keeping thermoelectric withdrawals separate from industrial and hydroelectric withdrawals), and to determine the point at which lower water withdrawal designs are more favourable, even if the required capital cost is higher.
http://www.fao.org/3/a-bc822e.pdf

Municipal and industrial water withdrawal modelling for the years 2000 and 2005 using statistical methods
This document describes the efforts to generate models that estimate the municipal and industrial

water withdrawals for the years 2000 and 2005.
http://www.fao.org/3/a-bc821e.pdf

Disambiguation of water statistics
The nomenclature surrounding water information is often confusing and gives rise to different interpretations and thus confusion. When discussing the way in which renewable water resources are utilized, the terms water use, usage, withdrawal, consumption, abstraction, extraction, utilization, supply and demand are often used without clearly stating what is meant.
http://www.fao.org/3/a-bc816e.pdf

FAO-AQUASTAT questionnaire on water and agriculture
These annual Guidelines and questionnaires have been prepared specifically designed to collect the SDG 6.4. related water variables, and therefore to update the core variables in AQUASTAT database.
http://www.fao.org/aquastat/en/overview/methodology/

International Recommendations for Water Statistics
The International Recommendations for Water Statistics (IRWS) were developed to help strengthen national information systems for water in support of design and evaluation of Integrated Water Resources Management (IWRM) policies.
https://unstats.un.org/UNSD/envaccounting/irws/

UNSD/UNEP Questionnaire on Environment Statistics – Water Section
http://unstats.un.org/unsd/environment/questionnaire.htm
http://unstats.un.org/unsd/environment/qindicators.htm

UNSD 'National Accounts Main Aggregates Database'
http://unstats.un.org/unsd/snaama/selbasicFast.asp

Quality assurance:

Every data in AQUASTAT goes through a thorough validation process.

Before uploading, data is compared to other variables to ensure it is logically correct (in other words: 1+2=3) and whether the reference used is not leading back to AQUASTAT itself. In other words, AQUASTAT frequently finds data for 2014, which is really AQUASTAT data for 2000 with the year changed (most probably when the data was harvested).

Also during the validation process each new data-point is compared to other data already available for this variable in other years or in the same year. If it is impossible to harmonize or reconcile the different data, then one or the other data-point has to be deleted from the database.

During uploading into the Main Database, another validation process takes place, using a set of about 300 validation rules. Of these, about 100 rules are obligatory rules, which means that if the data-point doesn't obey this rule, the validation process cannot go on. For example, the cultivated area of a country cannot be larger than the total area of the country. The other set of about 200 validation rules are warning signs for the person doing the validation. For example, in general the area equipped for irrigation using surface irrigation technology is at least half of the total area equipped for irrigation. However, in some countries the localized irrigation area or the sprinkler irrigation area might be larger than the surface irrigation area. If this is the case, then a warning pops up during validation for the analyst to check whether for this country it is possible.

Beyond the usual AQUASTAT validation described above, in the compilation of the indicator countries will be encouraged and supported in setting up their own quality control system, ensuring that all data used in the computation are checked, and that consistency is kept over the years to ensure comparability and robust identification of trends.

The indicator requires data from different sectors of expertise. Internationally, they are available of different datasets from various institutions, such as FAO, UNSD and IWMI. Each of these institutions has its own established mechanism to consult and validate the data with the countries.

For the data deriving from FAOSTAT and AQUASTAT, data are collected in countries through surveys consisting of data collection and country description by means of a detailed questionnaires were the source reference and comments are associated with each value, through officially nominated national resource persons. Critical analysis of information and data processing is done by FAO staff.

However, for the SDG process a specific mechanism will be put in place, consisting in the identification in each country, by the national government, of a national focal point and a technical team, in charge of the collection and computation of the indicator, in close consultation with FAO. This system has been successfully tested during the initial phase of the GEMI project, carried out by FAO and other seven UN agencies, coordinated by UN-Water.

For those countries that could initially have difficulties in compiling and computing the indicator, FAO will provide support and ultimately will be able to produce the indicator starting from internationally available data. However, no data will be made public without the prior approval by the relevant national authorities.

Data sources

Description:

Data for this indicator are usually collected by national ministries and institutions having water-related issues in their mandate, such as national statistics offices, ministries of water resources, agriculture, or environment. Official counterparts at country level are the national statistics office and/or the line ministry for water resources. More specifically, FAO requests countries to nominate a National Correspondent to act as the focal point for the data collection and communication. Data are mainly published within national statistical yearbooks, national water resources and irrigation master plans, and other reports (such as those from projects, international surveys or results and publications from national and international research centres).

The data for the indicator are collected through questionnaires to be answered by the relevant institutions in each country. Examples of the questionnaires that can be used can be found at:

AQUASTAT

http://www.fao.org/aquastat/en/overview/methodology

UNSD/UNEP

http://unstats.un.org/unsd/environment/Questionnaires/q2013Water_English.xls

OECD/Eurostat

http://ec.europa.eu/eurostat/ramon/coded_files/OECD_ESTAT_JQ_Manual_version_2_21.pdf

Collection process:

1. Official counterparts at country level are the line ministry for water resources and the national statistics office. FAO requests countries to nominate a National Correspondent to act as the focal point for the data collection and communication.

2. Countries are expected to put in place a process of Quality Control (QC), Quality Assurance (QA) and data verification. The process should be carried out internally for the QC part, ensuring that all the planned steps are properly carried out at each round of data collection. The QA should be carried out by independent experts, either national or international, to assess the consistence and robustness of the data produced. Finally, where possible the resulting data should be verified by comparison with similar data from other sources.
3. After the data are collected, harmonization will be needed among the eventual differences in definitions and aggregations.

Data availability

Description:

Countries (2010 to present):

Asia and Pacific 23

Africa 18

Latin America and the Caribbean 17

Europe, North America, Australia, New Zealand and Japan 41

Countries (2000-2009):

Asia and Pacific 42

Africa 49

Latin America and the Caribbean 27

Europe, North America, Australia, New Zealand and Japan 47

Time series:

1961-2017 (Discontinuous, depending on country) Data are interpolated to create timelines.

Disaggregation:

Although the indicator is based on total water volumes, sectoral data are needed to be able to disaggregate it in order to show the respective contribution of different sectors to the country's water stress, and therefore the relative importance of actions needed to contain water demand in the different sectors (agriculture, services, and industry).

At national level, water resources and withdrawals are estimated or measured at the level of appropriate hydrological units (river basins, aquifers). It is therefore possible to obtain a geographical distribution of water stress by hydrological unit, thus allowing for more targeted response in terms of water demand management.

Calendar

Data collection:

Annually

Data release:

Data for the indicator are planned to be produced for most countries on an annual basis since 2018 and are usually published in AQUASTAT every year in January.

Data providers

Description:

National Statistical Offices through AQUASTAT National Correspondents. The institutions responsible for data collection at national level vary according to countries. However, in general data for this indicator are provided by the Ministry of Agriculture, Ministry of Water and Ministry of Environment, and other line ministries.

Data compilers

Food and Agriculture Organization of the United Nations (FAO) through AQUASTAT, its global water information system (http://www.fao.org/aquastat/en/).

References

URL:

http://www.fao.org/aquastat/en/

References:

Food and Agricultural Organization of the United Nations (FAO). AQUASTAT, FAO's Global Water Information System. Rome. Website http://www.fao.org/aquastat/en/.

The following resources of specific interest to this indicator are available on these sites:

AQUASTAT glossary (http://www.fao.org/aquastat/en/databases/glossary/)

AQUASTAT Main country database (http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en)

AQUASTAT Water use (http://www.fao.org/aquastat/en/overview/methodology/water-use/)

AQUASTAT Water resources (http://www.fao.org/aquastat/en/overview/methodology/water-resources/)

AQUASTAT publications dealing with concepts, methodologies, definitions, terminologies, metadata, etc. (http://www.fao.org/aquastat/en/resources/publications/reports/)

IWMI – Global environmental flows assessment
http://eflows.iwmi.org/

IWMI - Global Environmental Flow Information for the Sustainable Development Goals
http://www.iwmi.cgiar.org/Publications/IWMI_Research_Reports/PDF/pub168/rr168.pdf

UNSD/UNEP Questionnaire on Environment Statistics – Water Section
(http://unstats.un.org/unsd/environment/qindicators.htm)

Framework for the Development of Environment Statistics (FDES 2013) (Chapter 3)
http://unstats.un.org/unsd/environment/FDES/FDES-2015-supporting-tools/FDES.pdf

OECD/Eurostat Questionnaire on Environment Statistics – Water Section

Related indicators

6.4.1: Change in water-use efficiency over time

6.1.1: Proportion of population using safely managed drinking water services

6.3.1: Proportion of wastewater safely treated

6.6.1: Change in the extent of water-related ecosystems over time

6.5.1: Degree of integrated water resources management implementation (0-100)

2.4.1: Proportion of agricultural area under productive and sustainable agriculture

15.3.1: Proportion of land that is degraded over total land area

1.5.1: Number of deaths, missing persons and persons affected by disaster per 100,000 people [a]

11.5.1: Number of deaths, missing persons and persons affected by disaster per 100,000 people [a]